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TEST PROCEDURE FOR ELECTRONIC ACCELERATION DETECTORS - PICKERING NGS

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Electronic Acceleration Detectors are being installed on Pickering NGS units 1 to 4 to replace auxiliary governors which have been shown to be unacceptable from a power system stability aspect. The new detectors are now in service on units 1, 3 and 4 and will be in service on unit 2 in mid-1988. Since the correct performance of the governing system depends on this equipment, periodic tests are required to assess its reliability and dependability. This report describes a procedure which can be used by station personnel to test the equipment.

1.0 INTRODUCTION

References 1 to 6 describe the shortcomings of the original Auxiliary Governors and the modifications to the Electronic Acceleration Detector carried out before the equipment went into service. The Acceleration Detectors are required on Pickering units 1 to 4 to handle situations where more than 50% of the generator load is suddenly rejected. Under such circumstances, the existing mechanical governor alone is unable to maintain the turbo-generator speed below the setting of the overspeed trip bolts. (The acceleration detector function is essentially duplicated by a pallet switch on the switchyard breaker but if the breaker does not open, as could be the case for a system fault close to Cherrywood, then the acceleration detector function is required.) Due to the importance of having this equipment function correctly when needed, and because it is not called on to act except on rare occasions, it is necessary to have a regular testing program to ensure a high dependability of the equipment. This report will describe a comprehensive test procedure to be used by station personnel to carry out this task.

To avoid confusion with acronyms for the existing Electric Anticipatory Device (EAD) and the Electronic Acceleration Detector Device (EADD), the term Acceleration Detector (AD) will be used in this report. This naming convention, or a similar one, should be used at the station.

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2.0 TESTING PHILOSOPHY

The testing instructions provided in appendices A and B of this report are divided into two parts, one covering routine on-line tests performed with readily available equipment, and the second part covering a comprehensive program to be performed during major unit outages. Based on experience with the reliability of similar equipment at Pickering B, and taking into account the need to keep personnel training up-to-date, it is recommended that the on-line tests be performed at two-month intervals.

It is expected that station personnel will add the necessary items regarding hazards, other precautions and rules normally followed in testing equipment at the station. A proper "test report" with the appropriate blanks could also be prepared by them if required.

ACKNOWLEDGMENTS

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REFERENCES

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2. Dr. P. Kundur, "Pickering A NGS - Electronic Acceleration Device". Memorandum to Mr. A. J. Haberhauer, October 1, 1981.

3. R. E. Beaulieu, "Electronic Acceleration Detectors for Pickering A NGS Governors". Ontario Hydro Research Report No. 81-195-K, May 28, 1981.

4. R. E. Beaulieu, "Proposed Modifications to the Electronic Acceleration Detectors - Pickering A NGS", Ontario Hydro Research Report No. 81-419-H, November 12, 1981.

5. R. E. Beaulieu, "Modified Electronic Acceleration Detectors - Pickering NGS A", Research Report 83-199-H, June 2, 1983.

6. NEI Electronics Ltd., "Operating and Maintenance Instructions for the Electronic Anticipatory Device Installed at Pickering Power Station", March 26, 1980.

APPENDIX A

A.0 PROCEDURE FOR PERIODIC ON-LINE TESTS

A.1 Preliminary Work

To perform the on-line test of the Acceleration Detector (AD) it is necessary to remove the equipment from service using the blocking switches installed in the AD cabinet. The blocking switches insure that no valve operating signals are issued during the tests.

Prior to performing the tests, the unit operator must be notified that this equipment will be out of service for approximately five minutes. No special action is required by the unit operator while these tests are performed. It is not advisable to remove these detectors from service when the risk of a unit load rejection is higher than normal.

A.2 Test Procedure

A.2.1 **Open all the blocking switches located at the top of the panel inside the AD cubicle.**

A.2.2 Check that all the indication lights are off on the ON-LOAD-TEST module. If some lights are on, press reset to clear them.

A.2.3 Check that the two power supplies are operating correctly by monitoring the voltages on the "+ve" and "-ve" test points on the speed detector modules. The levels are +26 and -26 volts dc. The light indicators on each supply should not be taken as an indication that the voltages are at their normal values.

A.2.4 With a multimeter set to measure dc voltages, measure the signals on test point 8, 9 and 10 of each SPEED DETECT MODULE. The signals should be:

TP8	=	-8.33 volts, $\pm$0.1 volt
TP9	=	0.0 volt, $\pm$0.15 volt
TP10	=	0.0 volt, $\pm$0.15 volt

If the test point signals are not as above, repairs must be carried out immediately. It will be necessary to readjust the auxiliary governor setpoint to a value of 2% (from 5%) if repairs which will take more than thirty minutes are to be carried out.

A.2.5 Test channel 1 by moving the CH.1 TEST SELECT switch to the **ON** position. Immediately this is done the CH.1 ACCN. OPER. light will come ON. Reset this light by pressing the RESET button. Now, press on the INIT. ACCN. switch downwards and hold for 3 seconds. The CH.1 ACCN. OPER. light will come ON. Reset the light.

A.2.6 Return CH.1 TEST SELECT switch to the **OFF** position. Reset the lights.

A.2.7 Test channel 2 by moving the CH.2 TEST SELECT switch to the **ON** position. Immediately this is done the CH.2 ACCN. OPER. light will come ON. Reset this light by pressing the RESET button. Now, press on the INIT. ACCN. switch downwards and hold for 3 seconds. The CH.2 ACCN. OPER. light will come ON. Reset the light.

A.2.8 Return CH.2 TEST SELECT switch to the **OFF** position. Reset the lights.

A.2.9 Test channel 3 by moving the CH.3 TEST SELECT switch to the **ON** position. Immediately this is done the CH.3 ACCN. OPER. light will come ON. Reset this light by pressing the RESET button. Now, press on the INIT. ACCN. switch downwards and hold for 3 seconds. The CH.3 ACCN. OPER. light will come ON. Reset the light.

A.2.10 Return CH.3 TEST SELECT switch to the **OFF** position. Reset the lights.

A.2.11 If all three channels tested OK, proceed to check the overall logic by causing the operation of two channels simultaneously. This is accomplished per the steps below.

A.2.12 Move the CH.1 TEST SELECT switch to the **ON** position. Immediately this is done the CH.1 ACCN. OPER. light will come ON. Reset this light by pressing the RESET button. Leave the CH.1 TEST SELECT switch to the **ON** position and move the CH.2 TEST SELECT switch to the **ON** position. Now return the CH.1 TEST SELECT switch to the **OFF** position. This action will cause channels 1 and 2 to operate simultaneously, operating the overall logic. The time delay in Relay 11 can be checked by counting the seconds it takes from the time the logic first operates to the time the relay resets. The clicking sound of the relay will indicate the operation and reset of the logic. The timer is set for 5 seconds.

A.2.13 If all the tests are successful, the equipment is ready to be returned to service. Return all TEST SELECT switches to OFF. Press the RESET button to reset all the light indicators.

A.2.14 **Prior to closing the blocking switches, measure continuity across the jaws of each set of switches to ensure that the AD circuits are all back to normal (see column 2 of table 1).** Use an ohmmeter for the continuity checks. Close all the blocking switches. Notify the operator that the equipment is back in service.

As a help to identify which set of switches are normally opened and which are normally closed, refer to attached schematic, drawing NA44-EMC-64117-1086, as revised in October 1987. Note that the drawing does not show the letters by which the jaws are numbered in front.

APPENDIX B

B.0 CALIBRATION PROCEDURE FOR MAJOR OUTAGES

B.1 General

The procedure which follows is to be used by qualified personnel to perform a major calibration and verification of both the Acceleration Detector and the On-Load Test Module. Specialized equipment is required, as outlined below.

B.2 Preliminary Work

B.2.1 Inspect all the wiring associated with the AD to ensure that there are no visible signs of damage. In particular, check the components on the "COMPONENT BOARD" located inside the cubicle for signs of overheating resistors, etc.

B.2.2 Check the integrity of all leads and calibrate all the test equipment, function generator, recorder, etc.

B.3 Power Supply Checks

B.3.1 Remove fuses F2 to F22 and energize the dc power supplies and check their output voltages on the "+ve" and "-ve" test points on the speed detector modules. The levels are +26 and -26 volts dc.

B.3.2 If the output voltages are as per specification, open ac supply, install all fuses for one supply and check that all the modules are energized from the one supply. Repeat with the other supply energized and the isolator of the first supply opened. Use test points TP1, TP2 and TP3 to verify the supply on each module. TP3 is common and TP1 and TP2 are +15 and -15 volts respectively.

B.3.3 Check that the loss of one supply causes the alarm relay to initiate AN446 for G1 and G2 or AN1002 for G3 and G4 in the Control Room.

B.3.4 Check that the loss of both supplies does not cause the signal to the valves to be issued (AN235 or 1003 in the control room do not come on), but an alarm (AN446 or 1002) should be given in the control room.

B.3.5 Energize both supplies.

B.4 Speed Signal Inputs

B.4.1 Disconnect the speed signal inputs from the three speed probes at the cubicle location (TBA terminals 61 to 66). Use a programmable function generator to simulate the speed signal.

B.4.2 Set the speed signal frequency at 480 Hz and verify that all the test point signals are correct. Normal values are shown below.

TP1 = +15 V POWER SUPPLY
TP2 = -15 V POWER SUPPLY
TP3 = COM OF POWER SUPPLY
TP4 = SPEED PULSE AT VERY LOW AMPLITUDE
TP5 = NOT USED
TP6 = N. R. SPEED TEST INPUT (0 V)
TP7 = NOT USED
TP8 = WIDE RANGE SPEED = 8.33 V
TP9 = NARROW RANGE SPEED = 0V, 12% speed deviation=10 V
TP10 = ACCELERATION = 0 V, 15%/sec=10 V

B.4.3 With the programmable function generator set to simulate a 5%/sec acceleration verify that the electronic modules detect this acceleration and close their output relays to initiate valve closure. It is sufficient at this stage to simply monitor the LED on the ON-LOAD test module to detect operation of the SPEED DETECT modules.

B.4.4 Repeat B.4.3 with a 4%/sec acceleration and verify that the modules do not operate.

B.5 Check of the Logic

A multichannel recorder is used to record test point signals and relay operations. Contacts are monitored across terminals 40 to 55 on TBA. Refer to main schematic.

B.5.1 Use a three phase ac supply through a variac to simulate generator terminal voltage feeding the positive sequence filter RXTBEB4. Voltage level is 120 volts line-line under normal conditions. Voltage will be varied between 80 and 120 volts to simulate various conditions. **NOTE THAT IF THE PHASING OF THE 3-PHASE SUPPLY IS INCORRECT, THE SEQUENCE FILTER IN THE ACCELERATION DETECTOR WILL NOT BE GENERATING THE CORRECT VOLTAGE.** If the phasing is correct, the signal on TB-C, 6 & 7 will be 36 volts with 120 volts input.

B.5.2 With the three-phase voltage at 120 volts, simulate an acceleration of 6%/sec for all three acceleration modules. Observe that the valve closing signal appears on TBA terminals 40 to 55, immediately the SPEED DETECT modules operate. Drawing NA44-EMG-64117-1086, revised Oct. 1987, indicates which terminals are normally opened and which ones are normally closed.

B.5.3 With the three-phase voltage at 80 volts, simulate an acceleration of 6%/sec for all three acceleration modules. Observe that the valve closing signal is delayed by the time setting of timer RXKB1 (approximately 125 ms).

B.5.4 Repeat B.5.2 and B.5.3 with speed detector channel one out of service. Operation should be as before.

B.5.5 Repeat B.5.4 with channel two out of service and then channel three out of service, one at a time.

B.5.6 Repeat B.5.2 and B.5.3 with two channels out of service. No valve closing signal should be issued.

B.5.7 Verify that relay RL11 has the desired seal-in time to maintain the valves closed for the required amount of time. The setting is 5 seconds as of December 1987. The seal-in time is measured from the time the Speed Detector Module resets. When using a programmable function generator, the reset of TP10 is taken as time T=0.

B.5.8 Verify that the Remote Fault Indication operates for loss of one or more speed signals, spurious operation of one or more modules and failure of one or more power supply modules.

B.5.8 Verify that the AD does in fact operate the steam valves by performing a dry test of the full logic all the way to valve actuation. **(This part is optional and is left to the discretion of the station personnel. It may be sufficient to check the signals across the blocking switches.)**

B.6 Verification of ON-LOAD Test Module

The ON-LOAD TEST MODULE contains a simple sweep generator set to provide a "speed" signal which starts at 480 Hz and sweeps upwards at the rate of 6%/second for approximately 2 to 3 seconds. It is essential that this module be calibrated during major outages to ensure that periodic on-load tests yield accurate results. The following steps will perform this calibration, using one of the SPEED DETECT module as a frequency to voltage converter.

B.6.1 Program the portable sweep generator for a 6%/sec acceleration, with a start frequency of 480 Hz. (Output of this generator still connected to the speed probe terminals as in B.4.1 above) Initiate a sweep on the generator and record Test Point 10 of the SPEED DETECT modules on the chart recorder. Measure the amplitude of the signal on TP10 for a 6%/s acceleration. The signal should be 3 volts, ±0.2 volt.

B.6.2 Move the CH.1 TEST SELECT switch to the ON position. Immediately this is done the CH.1 ACCN. OPER. light will come ON. Reset this light by pressing the RESET button. Now, press on the INIT. ACCN. switch downwards and hold for 3 seconds. Record Test Point 10 of the SPEED DETECT module, channel 1, on the chart recorder. Measure the amplitude of the signal on TP10 and compare to the signal measured in B.6.1. The two values should be within 0.2 volt of each other.

B.6.3 Measure the signal on TP4 of the ON-LOAD Test Module with an oscilloscope. The signal should be a sine wave with an amplitude of approximately 6 volts peak-peak and a frequency of 480 Hz, ±10 Hz.

B.7 Verification of Speed Probes

This part of the procedure is performed immediately following a major outage, once the generator has reached rated speed and before it is synchronized to the grid. It is important to perform this check as there is always a likelihood that the probes were damaged during the outage.

B.7.1 With the generator at rated speed, and the speed signals reconnected, check that the three probes deliver a signal of at least 8 volts zero-peak on TP4 of each SPEED DETECT module. Record waveforms on an oscilloscope and camera.

B.7.2 With the normal speed signal feeding the modules check all test points on the three modules and compare to values provided in manual.

B.8 Verification of Generator Terminal Voltage Signal

With the generator running on open circuit, rated speed and rated terminal voltage, measure the voltages on terminals TB-B 1, 2 and 3. The voltage should be 120 volts line-line. Measure the voltage on terminals TB-C 6 and 7. A voltage of 36 volts ac should be on these terminals.

B.9 Use of Auxiliary Governor

Following the initial successful commissioning of the Acceleration Detectors on all the units, the auxiliary governor was reset at approximately 5% overspeed. If it is necessary to remove the Acceleration Detector from service for a period of time in excess of thirty minutes, then the Auxiliary Governor must be reset to 2%.

B.10 Equipment Required

Programmable function generator with sweep function to simulate speed signal and acceleration: HP model 3314A Function Generator, or equivalent. (A combination of a Voltage-Controlled Oscillator and ramp generator can be used instead)

6-Channel direct writing recorder, Gould Model 2600S or equivalent.

3-Phase variac suitable for voltage supply available at station. (Relay panel in same room as AD has a three phase, 120V supply)

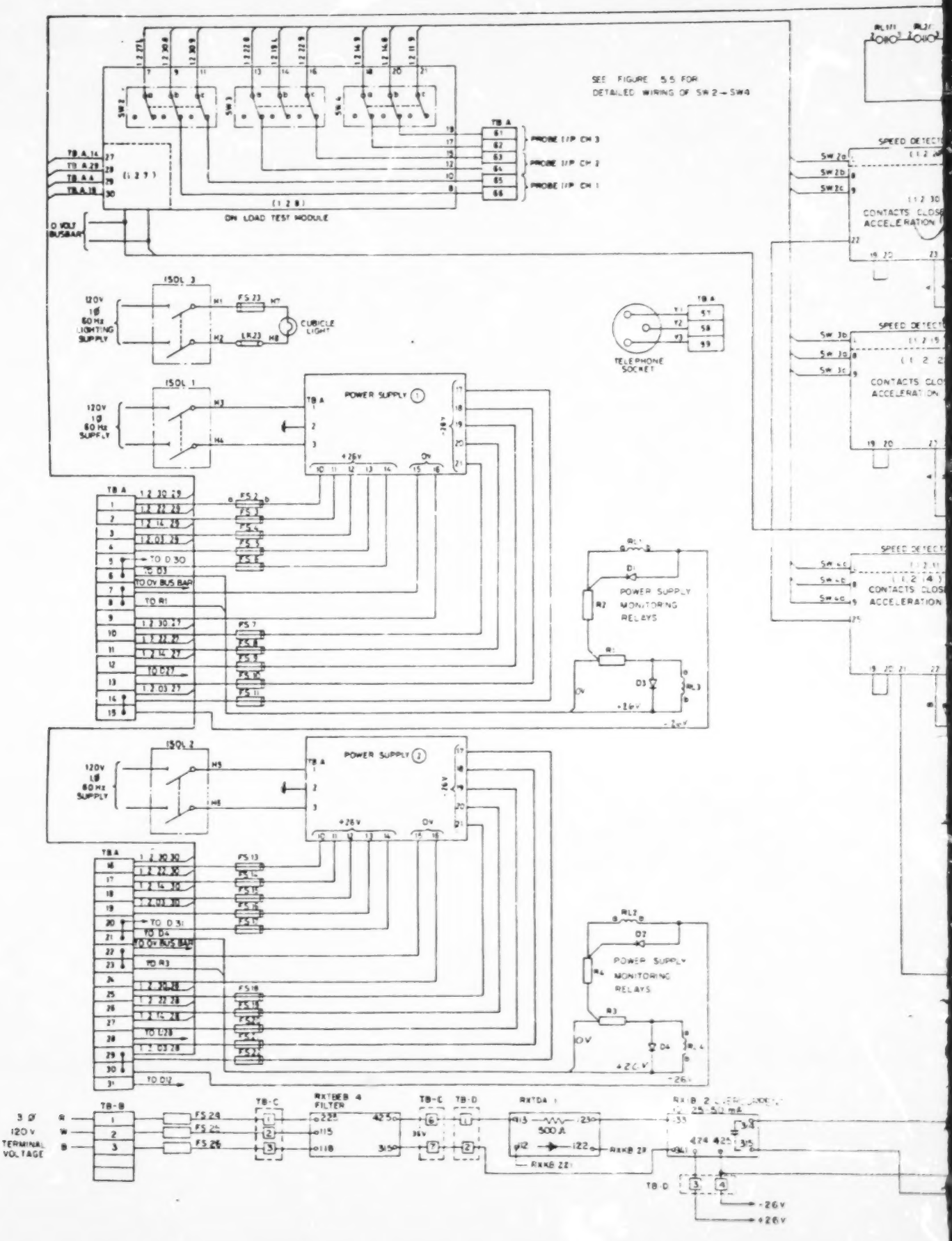
Updated AD manual

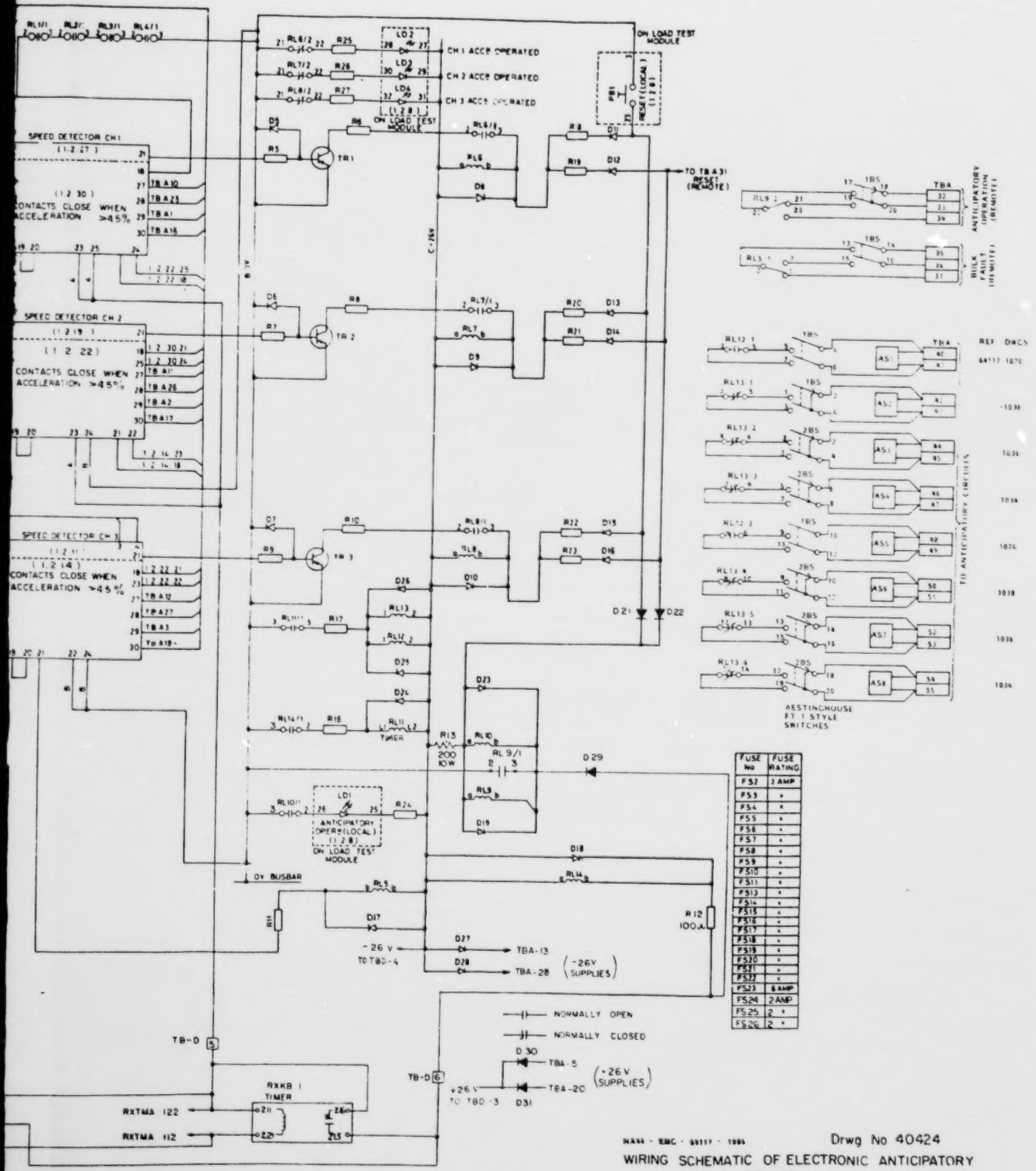
Full set of drawings for the equipment and interface to governor

TABLE 1

CHECKING OF ACCELERATION DETECTOR OUTPUT

BLOCKING SWITCH CONTACTS	STATE WITH ACCEL. GREATER THAN 5%/s	STATE WITH ACCEL. LESS THAN 5%/s
1BS A-B	OPEN	CLOSED
1BS C-D	CLOSED	OPEN
1BS E-F	CLOSED	OPEN
1BS G-H (AD FAULT ALARM)	CLOSED	CLOSED
1BS I-J	OPEN	CLOSED
2BS A-B	OPEN	CLOSED
2BS C-D	OPEN	CLOSED
2BS E-F	OPEN	CLOSED
2BS G-H	OPEN	CLOSED
2BS I-J	OPEN	CLOSED


SEE FIGURE 5.5 FOR DETAILED WIRING OF SW 2 → SW 4
SW 2
SW 3
SW 4
TB A
PROBE I/P CH 3
PROBE I/P CH 2
PROBE I/P CH 1
TB A 14
TB A 29
TB A 4
TB A 18
DH LOAD TEST MODULE
0 VOLT BUSBAR
ISOL 3
120V 1Ø 60 Hz LIGHTING SUPPLY
FS 23
CUBICLE LIGHT
TELEPHONE SOCKET
ISOL 1
120V 1Ø 60 Hz SUPPLY
POWER SUPPLY (1)
+26V
0V
TO D 30
TO 0V BUS BAR
TO R1
TO D 27
TO D3
POWER SUPPLY MONITORING RELAYS
ISOL 2
POWER SUPPLY (2)
TO D 31
TO D4
TO R3
TO D2
3 Ø 120 V TERMINAL VOLTAGE
TB-B
FS 24
FS 25
FS 26
TB-C
RXTBEB 4 FILTER
TB-D
RXTDA 1
500 Δ
RXB 2
TB D
-26V
+26V



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WIRING SCHEMATIC OF ELECTRONIC ANTICIPATORY DEVICE

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